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AMMUNITION.

R. L. SACKETT,

President of the Society.

"The Challenge" in the September number of this JOURNAL was a call to arms for the rank and file of the Society.

That subject suggests weapons and ammunition. The figure is a poor one as this is not a combat but rather a debate. The ammunition has been supplied by the facts furnished in the investigation. It should be examined again to see whether it fits our purposes and our field of development.

The *Curricula* are plans of action and are, in general, sound. Are they the product of imitation or of careful analysis of ideas and ideals? They should be given an independent, judicious review. Perhaps they are just right, but times change.

Entrance Requirements are naturally similar but can our practice in admitting students be improved? Is a special examination in English valuable? What does it tell? Psychological tests? What is your experience with them? It might be profitable to have a symposium on that subject from the laity and see how their opinion agrees with those of the psychologists.

Students. The curriculum may not be very important and entrance requirements may vary, but the quality of students applying and entering is certainly a paramount issue. They are the materials with which the teacher works.

How can we interview before entrance? If this is impossible, then would it not be well to interview after entrance? Many institutions have "student advisers." Does it work? If not, why not?

Are we tending too much toward paternalism? Certainly some students need fatherly advice in the Freshman year. Do they get it?

Is the mortality high in the Sophomore year? Perhaps there is clear reason for it and the institution is satisfied. Has the question been studied?

High mortality from poor scholarship in the Junior and Senior years, if it occurs, seems to raise questions.

We have plenty of ammunition and targets. How is our marksmanship?

ADDRESS OF WELCOME!

BY PRESIDENT H. S. BOARDMAN,
University of Maine.

It is not my intention to make any set or extended speech. In following this Society as I have since 1915 (and I think I have to my credit every year since that time) I have learned to love it. I have made a great many friends and I feel that we are all one big family. We know what our aims and purposes are and I do not feel that it is up to me to enlarge upon that.

So in my welcome to you, I shall make a very few, brief statements. The first is that I sincerely welcome you into the State of Maine and especially to the University of Maine. We have all kinds and classes of institutions in the country and each institution should see what kind of a job it needs to do and should strive to do that job well. That is what we are trying to do here. We are essentially a country college and will always remain so. We have a registration of about sixteen hundred and we are not looking toward increasing that registration any material amount. We have more calls along coeducational lines than we can supply. We have to turn away every year a considerable number of girls. Governor Brewster, in an address recently, made the statement that in the State of Maine the institutions of higher education could only take care of one girl in ten. I think that is true. He advocates the founding of a woman's college. We have none such in the State. We have four institutions: Bates, Bowdoin, Colby and Maine. Bowdoin does not take any girls. The other three institutions are coeducational.

We have our peculiar problems the same as do you all and in wrestling with those problems and in solving them, we really get a good deal of pleasure.

I think that the beauties of the State will speak for them-

selves. We have arranged (I say "we" but it is under the direction of Dean Cloke. I can't get away from the engineering end of things) what we think is a good program, one of sightseeing and pleasure as well as the program of work which has been arranged for you. We hope you will avail yourselves of all the opportunities.

That is about all I have to say, and let me repeat that we do sincerely welcome you to the University in the State of Maine and we hope you will take away with you a very pleasant recollection of your stay.

And now, Mr. President, at this time it becomes my very pleasant duty to present to you a gavel which is made from State of Maine hardwood which was colored while growing. It is a peculiarity of this State that we do a great many things a little differently from any other State. I doubt whether in your State, Mr. President, you have anything so unique.

I again extend to you, Mr. President, and all of the people assembled the courtesies of the institution.

RESPONSE.

BY O. M. LELAND,

President of the Society.

I know I voice the sentiments of the entire body present when I say it is delightful to come to the State of Maine, and to the University of Maine for this meeting.

The State of Maine, I suppose, needs no introduction to most people. I believe it is universally accorded the first place in the list of states in the United States ever since geography in our schools was common. We all began the United States with Maine, New Hampshire, Vermont, etc.

Also I feel that we are very fortunate in coming to the State of Maine and to the University of Maine in that one of our own number is welcoming us—as the head of this institution. Of course we expect our engineering people to take places of responsibility. We expect them to have duties and responsibilities thrust upon them, and of course we congratulate the University of Maine and the trustees of the institution on their good sense in selecting one of our number. We can not say that we sympathize particularly with the victim.

We appreciate the courtesies that have been extended to us thus far. For the benefit of those who were not in the caravan that proceeded from Burlington over to Maine, I wish to state that at the borders of this State, we were met by an official representative of the State Police who escorted us safely into the University grounds. It remains to be seen whether we will need a guard going out, but I assume that we will not.

Maine, of course, is the mother of tourist states. I suppose there is no one other state in the Union that has made such a business or had such business thrust upon it as the State of Maine in welcoming tourists, because Maine was a tourist state as soon as States in the Union were organized.

This is my first experience in the State of Maine, my first visit to the State, and I feel that the Society is fortunate in having such a delightful place for its meeting, in having a University—as you call it, a country University—at which it can meet, where the members can live together, and associate intimately while we are in the midst of our deliberations.

I accept this gavel as evidence of your good wishes. It is a symbol of authority, and I hope that the members of the Society at the close of the meeting will feel that it has been used reasonably for the dispatch of business and not as an implement of obstruction.

WELCOME!

BY HON. RALPH O. BREWSTER,

Governor, State of Maine.

Mr. Presiding Officer, Mr. Retiring President, and Friends: I was told by your genial and efficient Secretary that he felt very safe in going forward with the meeting as I was the last speaker; the Retiring President's address had been carefully prepared, of definite duration, and he had just been informed by a high authority that I was a very well educated man, as I knew when to stop speaking.

It is not surprising that other people should not understand the term, but as engineers you should certainly understand the function of a governor. The last toastmaster to introduce several other "peace" offerings as well as myself, began by saying that what America needs more than anything else (to paraphrase the famous saying of Thomas Marshall) is a good five-minute speaker, and hoped to produce the prize before the evening was over.

It is a very real pleasure to welcome you here to the State of Maine, somewhat tardily, as one of your number assured me that he was welcomed at the border yesterday morning officially by a member of the State Highway Police, whether as a suspicious character or a speedy character, I do not know, but he seems at least to be out on bail.

We trust, however, that your journey in some instances from such a distance, will be rewarded by some of the pleasures or the profit that you may gain. We have long recognized that we were very near to the hub of the universe. Your genial Presiding Officer, born in Rhode Island and educated there (I don't know whether he is a Rhode Island red or not), going South to Virginia, has finally arrived back to the haven of all good Yankees here in the State of Maine. Some of you have come from farther distances than that in the political poles that separate us in those two great commonwealths.

We have rejoiced that we were gradually being discovered in this most northeastern section of the United States; more and more we believe in that saying ascribed to Emerson, that if you build a better mousetrap, or write a better book, or preach a better sermon than your neighbor, the world will make a beaten track to your door. A track has been beaten up to Maine and in ever-increasing number our visitors are coming over our roads that our well-trained engineers are preparing for the delectation of a hundred million people of the United States.

But I was disturbed on coming here and being faced by Mr. Bishop, your secretary, with a proposal, as I looked out over this most obviously intelligent gathering, that he made with what we might almost say was braggadocio, that assumption of superiority that seems to be characteristic of the engineering profession (so irritating to lawyers who hitherto have assumed that prerogative of superiority unto themselves). He said, "Now you ask me any engineering question that you wish and out of this host of distinguished gentlemen and ladies, I will produce on the spot the expert who can give you an immediate reply."

I have been in the business of employing experts for the last two or three years; I know they come high. That was too good an opportunity to pass up, as I have on my desk right now a question that the legislature estimated would cost eighty thousand dollars to answer. I wanted an answer. So I said, "What is a fair price for the power that is furnishing the illumination up there in that electric light?"

He said, "All right, I will give you the answer. I will call on Professor Scott."

He consulted Professor Scott from New Haven. He seemed to hesitate a little. I did not know whether they were considering the matter of price or not. Finally, he came over, brought the professor over and presented him. He said, "Ask him your question." So I repeated it: "What is a fair price for the power that is furnishing the illumination in that electric light?"

The professor said: "Down here in Passamaquoddy Bay, about a hundred miles from where we are, the tide runs between eighteen and twenty-six feet. Tremendous power rushes through there. The configuration of the earth is such at that spot, that they are considering the creation of one of the greatest tidal powers the world has ever known by the construction of dams, to cost approximately a hundred million dollars for the installation of machinery. Taking advantage of the fall of that tide, they anticipate the development of three hundred thousand or four hundred thousand horsepower. It may not be available twenty-four hours of the day because the cycle of the tide varies both in the day and the period of the year."

I said, "Professor, I was asking you about the electric light."

He said, "I am coming to that. You have to take into account the question of whether there is any other supplementary power available. We made a survey of your rivers falling a thousand feet from the plateau of 15 million acres timberlands that you have in your hills,—one of the greatest natural water-power systems in the world,—together with your large rainfall. We made a very careful study of that to see whether storage basins might be created that would stabilize that flow of power to supplement the tidal power here. We found that at one spot near Moosehead Lake we could build one of the greatest dams in the world, creating three hundred to four hundred thousand horsepower, which we could interchange and supplement, if necessary, with steam-generated power created at tide-water."

I said, "Professor, but what about the electric light?"

"Well," he said "of course we have to take into consideration also the character of the use, whether there is a steady demand available, whether it is a seasonal demand or a fluctuating demand. You have to consider to what extent you may regulate your flow or distribute the power both within and without the State of Maine. (We are the only State in the Union that does not permit any of its neighbors to share

in its hydroelectric power at this time.) We have to take all those things into account and whether you will let us take some of the power out. Then we have to consider what price we may use it for. You have to consider the character of the use, whether for light or power or industrial use or for agricultural use, and then comes next the question of distribution lines."

About this time I decided that he was not an electrical expert but a very good imitation of a lawyer or a judge. We have that reduced to a Latin phrase, which we use in reply when you come to ask us in law any such question as the cost of electric light. We do not go into any of these long circumlocutions and enumerate the million tourists that each year visit the State of Maine, leaving a hundred million dollars behind (of which we hope you have contributed your share) but we immediately and simply reply: "*Curiam advisare vult* which being interpreted meaneth—the Court wishes to take time to consider."

At your next annual meeting, I anticipate a reply. Meanwhile, I feel that to some extent I have called the bluff of your Secretarial expert. The engineer is rapidly supplanting the lawyer, for better or for worse, and as we pass over to you the palm that we thus far have cherished and nourished and that our clients have greased, you will assume the responsibilities with a due appreciation of all that is involved.

It is very easy to speak cavalierly of the great profession to which I belong, which so long has held as evenly as may be the scales of Justice and built up the great systems of jurisprudence under which our civilization has developed and under which you enjoy practically all of the prerogatives and privileges that are yours today. But it is a gigantic structure and it has now reached its fruition as the common law and the common lawyers seem to have reached practically the end of their rope in the development of the principles of jurisprudence and recognize frankly that we have now entered the domain of economics rather than law.

As you take that place that we have so long enjoyed, you

will enter into a broader field of education than the necessarily narrow and technical one concerned with the problems of your profession great as those necessarily are.

As a student at Harvard Law School—which we like to regard as one of the great professional schools of the world—where the science of the law had first its great development under the case system that applies those principles of science which have been developed in your profession with such remarkable success, it dawned upon a student that the danger to the successful service of society lay in becoming merely a lawyer and ceasing to be a man and that anxiety was presented to Dean Thayer, son of his predecessor in that great position. The Dean very wisely replied to this young man, "So long as you are worried about it, you have no need to be concerned."

And as you engage in that great responsibility of educating the young men and young women who in this next generation are going to determine whether the marvelously intricate mechanism that we have developed in this country—is to crush out civilized society or is to carry us forward to new heights of culture and attainment. This is going to be determined not by the intelligence of your faculties nor the educational processes of your schools, but by the character that you shall develop in the young men and young women that come within your charge.

Just as in the other great professions in the final analysis it has been recognized that the intellectual integrity and the civic service of the individual was after all the corner stone upon which the successful state must be built, you too must go forward in that great enterprise.

It was an inspiring lesson here on this very campus but two short weeks ago to hear the engineering graduates pledge themselves to the service of their great profession and to the service of our common land. But if that is confined within the narrow limits of being honest hired men, we shall utterly fail of solving the problems which are now staggering this country for solution if our civilization is not to fail.

Lawyers for generations have been the errand boys of businessmen as engineers in increasing measure must be, but there have always been those who have recognized a very high obligation of citizenship. They have enjoyed the calumny of being called demagogues in seeking to serve the interests of the state. As President Coolidge said, it is all right to be called a demagogue so long as you are not one. And in your engineering profession you must hold the balances even between the gigantic interests that are created with rather selfish ends to serve and the great common people who must after all rest for their protection upon the intellectual integrity that you bring to the service of our common land.

If it costs three mills to generate that power and sixteen cents is charged for its delivery here, that may be a fair or an unfair price. Fifty times the cost of generation! That is for the good professor to say. It is a problem that is impossible for a lawyer or a court to answer.

The legal principles covering the situation are very definitely determined. They were settled a century ago. The Supreme Court of the United States is still attempting to apply those principles but has left us in chaos as a result of the seemingly different decisions on every group of facts that present themselves because of the impossibility of comprehending the economic issues that are involved. The problem is and must be one for engineering experts and no one else.

As you assume this prerogative of the courts, the highest and greatest responsibility in administering justice between our fellow-men, you must take the same basis of civic service that has been the ideal and the goal of those leaders in our jurisprudence who have served so well in the centuries of our very simple past.

That is why we here in the State of Maine, struggling with this problem of power, rejoice that you gentlemen and ladies are assembling to consider the problems of engineering education, devoting yourselves for this time to determining how the youth of America may be better prepared to serve. Speaking from one profession now passing rapidly into innocuous

desuetude, to this other great profession that in this last generation has come so conspicuously to the fore, I can but say that you will do well to give emphasis in proper measure not merely to the technical preparation, but to the cultural and character development which can alone enable this mighty mechanism of modern civilization to survive. It is the Spirit of St. Louis, without Lindbergh at the helm, if we shall turn over to our children all this great heritage of modern civilization without that birthright of spiritual truth that guided America for three centuries as we moved to a position of preeminence among the nations of the earth. Turn your thought on occasion to things other than the immediate economic laws with which you are properly concerned.

"The laws that lawyers know about
Are property and land,
But why the leaves grow on the trees,
And why the waves disturb the seas,
Why honey is the food of bees,
Why winter comes and rivers freeze,
Why faith is more than what one sees,
And hope survives the worst disease,
And charity is more than these,—
They do not understand."

GRADUATE STUDY IN THE ENGINEERING SCHOOLS.*

BY DUGALD C. JACKSON,
of the Massachusetts Institute of Technology.

Before one can intelligently reflect on or discuss this subject it is necessary to take two underlying topics clearly in mind. These are:

What is the aim of graduate study in the engineering schools?

And the even more comprehensive topic, What is graduate study?

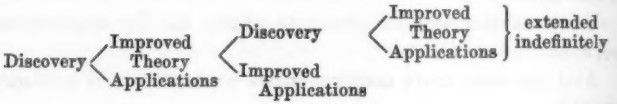
When invited to address this meeting on the subject it seemed to me well to outline and define these two topics as a directive of our thought. It is a characteristic of a developing science, profession, business, society or civilization that the connotations of words are likely to change. The central meaning of a word may continue, but its fringe of marginal meaning may change; in one instance the fringe may shrink and atrophy so that the meaning of the word becomes nucleated and more specific, while in other instances the fringes may expand and develop until the cloak of connotations becomes generally enough used to vie with or exceed in importance the original signification of the word. This is a sign of progress. A vividly living language is a growing language. Language has many characteristics in common with those ascribed to biological creatures. A stationary state too often spells ineffectiveness and is prophetic of decadence.

Engineering possesses a basis of underlying sciences and arts of such rapid growth in this age that the exponents of engineering education composing this audience may be expected to ascribe different intellectual pictures to various

* Presented at the Meeting of the Division of Deans and Administrative Officers at the 35th annual meeting of the Society, University of Maine, Orono, June 27–30, 1927.

words or groups of words commonly and mutually used by us. I therefore feel sure that my effort to define needs no apology.

Amazing, in the engineering industries, as are the variety and scope of useful applications of understood natural phenomena, still more amazing is the avidity with which new discoveries are directed into useful channels, and improved theories are seized upon as guides to improved or widened applications of old science. The inspired chain of intellectual and material development goes on with accelerated progress.



Improved applications often have the effect of arousing additional tastes, the desire to satisfy which produces "needs," and these cause additional stimulation to efforts for further discoveries and applications.

The engineer who makes or directs the applications may be and frequently must be as well versed in fundamental sciences as the scientific discoverer. Indeed the engineer and the discoverer of this age are not infrequently embodied as one individual, as also was the case, for instance, of Archimedes and Leonardo da Vinci, ancient but marvelous examples.

Our generation finds a new demand. Men are no longer playthings of nature nor pawns of kings and nobles. This is our great distinction over preceding ages. It is a distinction bearing the quality of elevated nobility. Character and service supersedes force for the principal moving cause in human society. Character is so mighty an influence that we approach the ideal where character coupled with intelligence, instead of brawn, makes might. Character is human. Its attributes include the factor connoted in the societarian relations by the word Service. Engineering and the education for engineering contribute to this elevated progress in a degree not yet sufficiently appreciated either in the world of education or in the world at large. Engineering education considers and ex-

pounds the known materials and forces provided by nature, it classifies their characteristics, their inter-relations and their relations to human affairs and human welfare, it encourages further discovery relating to materials and forces and itself aids in discovery.

The present generation plays its part with three major branches of applied science—agriculture, medicine and engineering. As we know them, these are all founded on modern scientific discoveries. Agriculture has not come forward commensurately with preventive medicine and the engineering industries. But with the automobile, the tractor, manufactured nitrates, diversified cropping, hard surfaced roads, electrical power in the rural communities all established, as they bid fair to be, agriculture may rival its brothers in wonders. The engineers have a responsibility in this. The problem of diversified cropping, I take it, is the farmers' own; but for the automobiles (whether for passengers or goods), the tractor, manufactured nitrates, hard surfaced roads and electric power, the farmer is compelled to look to engineers and the engineering industries. Even in sanitation, the practitioners of preventive medicine turn to engineering for the broader foundations like potable water supply, safe disposal of sewage and wastes, ventilation, heating and lighting.

Let me enumerate some of the grounds for the responsibility of the engineers in this nation:

Our population, relatively to that of the world, is not large, being only some six or seven percent of the total population of the earth, and it is located on a somewhat smaller proportion of the land-area of the world. But we are richly endowed. Large proportions of many of the world's most important commodities are produced by us. Some of those of which we produce more than half of the world's total production are pig iron, steel, copper, lead, zinc, petroleum, sulphur, timber. Their importance cannot fail of recognition. Our railroad lines comprise more than one-third of the mileage of the railroad lines in the world, and carry a traffic which, measured in ton-miles, is equal to the railroad traffic of the rest

of the world. We mine two-fifths of the annual coal supply of the world. We own automobiles in such multitudes and use telephones in such numbers that other nationalities look upon us in amazement. We furnish the workmen in our industries an amount of mechanical and electrical power as an aid to production, which is between two and three times as much per man, as is provided in any other nation. We have from eight to ten billions of dollars of savings each year to put into the expansion of creative enterprise, and this comfortable sum is the offspring of intellectual processes applied to improving and increasing production. We afford workmen mechanical power and power of mind, and provide supervisors who encourage them in the use of both.

Consider then our riches and our proportionate responsibilities. The engineers are largely responsible for means of producing the various commodities named, and for modern transportation and quick intercommunication. On them rests responsibility for farther development. On them also rests much responsibility for limiting and ultimately stopping the extraordinary wastes which occur now as characteristics of our processes of production and distribution. Such wastes cannot go on forever. They must be stopped. The unfolding of more refined methods of applying science to commodity production and distribution is a primary need. Necessity seems always to produce improved intelligence, and through suitable engineering education the processes of developing that improved intelligence may be guided and accelerated. The discovery of principles and the invention of improved methods of production or of improved methods of storage and of distribution are of high promise of fertility and profit to the world. The great work of our distinguished Secretary Hoover and his staff of men engaged in standardization and simplification of industrial practice is a sign of the times and its needs. In engineering, the days of the empiricists who carry on according to the ways of their fathers, because their fathers did so before them, are almost gone, and the days of scientific and economic background have come.

With such abundance of materials at elbow, we cannot do our duty to ourselves or to civilization if we follow the old, well-beaten, wasteful paths of practice determined by empiricism. The reduction of now incalculable wastes of men and materials, the improvement of methods, are responsibilities of the rising generation of engineers. The scientist engineer is the present bulwark of life and its comforts. The direct-minded engineering intelligence is a primary force in progress. Engineering education is planned with these things as a background.

In undergraduate engineering curricula we provide for a knowledge of natural phenomena and their inter-relations, some acquaintance with human affairs, a direct-minded facing of facts and direct-minded reasoning upon them. These curricula supply for young men the preparation for serviceability in the engineering world, with all of its great industries and public works, which is very valuable. In the administration of the curricula, we should try to inculcate a lively investigatory interest, and a spirit for individually continuing education which is signalized by the word "Commencement" often used to denote the exercises when diplomas are conferred by engineering schools and other institutions of education and learning.

The aim of graduate study in the engineering schools goes farther. It should enable the student to deepen his exploratory shafts and drive galleries in the fabric of physical and human phenomena and strengthen his grasp of their relationships. This process is intensive and individual. If gain is to be accomplished in reasonable time it requires the selection by each student of a rather specific aspect in the broader field of engineering which comprised his undergraduate studies; to which special aspect high emphasis shall be given by investigatory study and research. The aim being to improve depth, thoroughness of grasp, and investigatory resourcefulness and enterprise, it is quite apart from a process of expanding the range of studies by pursuing additional undergraduate subjects, such, for instance, as may be associated with a cur-

riculum in some branch of engineering collateral to the engineering branch characteristic of the curriculum originally pursued by the student, or such as may be found in some more distantly associated field of learning. For promising graduates who simultaneously are young enough to afford the time within their youth, are free of prohibitive obligations, and possess ambition for a creative career, my observation of numerous graduate students and their after careers shows that the fruits of pursuing this aim are manifestly large. I presume that those of us here who have enjoyed the advantages of such study will concur in support of its abundant fruitfulness.

The aim outlined goes far toward defining what graduate study is, but it is fitting to trace this latter thread still farther. The phrase "graduate study" in engineering when correctly interpreted, connotes individual, advanced study, under competent direction and encouragement, of some aspect of the student's chosen general field which he selects on account of his personal bent or interest. It is limited to few simultaneous topics, such as three or four, in order to be thorough (though collateral reading may be comprehensive) and is associated with scientific research. Engineering teachers sometimes confuse the word research as used in education by extending its sense to include conventional testing, measurements or computations in addition to veritable research; but there is in reality a notable distinction.

Research involves diligent search for a new or improved process, or a new principle or hitherto undiscovered combination of principles, or perhaps a new method of verifying already accepted facts. It calls for notable powers of extemporization and invention. It is an intellectual process of high order. Engineers holding posts of creative effort in designing structures, equipment or plant; in operation of plant; or in directive administration, must constantly invoke this process. Engineering education should aim at establishing ability in its use, and graduate study worthy the name consists substantially altogether of its exercise.

A survey in larger dimensions or requiring a peculiar bit of ingenuity, a test of a machine or a power plant by conventional codes, the assay of some ore of peculiar but already known qualities, a study of economic circuit locations or characteristics of known types, and such-like, which are examples of most undergraduate theses, are not research in the educational sense of that word's usage. They may give exercise in ingenuity in utilizing expedients for overcoming difficulties and call for some extemporization, and are good in their way; but they are not research. They are not aimed at establishing new processes, discovering new principles, or inventing and demonstrating new methods for independent verification of the known. Graduate study for engineering students must be pitched on a different standard from the undergraduate ideals of the majority of engineering schools.

A stage for effective graduate study in any branch of engineering requires comprehensive libraries and laboratories; and a teaching staff possessing notable grasp of the mathematical-physics and economics applicable in the branch concerned, a wide acquaintance with the manner of their applications, and a studious zeal for discovery. Laboring in paths chosen according to his individual tastes, located in an environment of facilities and an atmosphere of encouragement, the graduate student should be able to carry on with an intoxication of interest.

> For he on honey-dew hath fed
> And drunk the milk of Paradise.

The foundation of this spirit, moreover, should be developed in the undergraduate work.

Few engineering schools are prepared to provide such opportunities to seekers after graduate study. Teachers assigned to a traditional fifteen to eighteen hours per week of class teaching seldom have fertility left for the processes either of exacting inquiry or of stimulating the minds of graduate students. Only those exceptional ones who possess

superabundant energy and indestructible scientific curiosity can, under such conditions, successfully direct even occasional graduate students. Half the traditional number of assigned hours is often too many for a teacher in graduate work who, through his accomplishments and his subject, attracts many such students. Relief from an excess of hours of teaching and a limitation of subjects taught by the individual are pre-essentials to establishing adequate graduate work. The lecturer (*i.e.* the leader) in a graduate subject must be secure in the time and opportunity to make and hold for himself a place recognized for scholarly leadership in his specialty. The claims of study and creative investigation must be upon him always. His originality and resourcefulness and his productivity should stimulate his students. A topic for graduate study should grow year by year under the hand of the leader and his students, and each successive year it properly may be unfolded in the lectures from a new aspect. Laboratories equipped with standard forms of machinery and equipment (except fundamental measuring devices and ample sources of energy) are of little more service than museums of the arts for this stimulating and useful kind of study. Special devices to use in special investigations and measurements, brought to embodiment through improvisation and by expedients guided by scientific analysis, make up the major equipment for a laboratory for the purpose here under consideration. The equipment of such a laboratory is constantly changing; as the particular problems under investigation progress or are suspended. This of itself additionally serves to stimulate the enterprise, resourcefulness and self-reliance of the students who are associated individually or by groups with the various enquiries that are progressing in the laboratory.

Every teacher suitable for supervising the work of graduate students in engineering must possess notable analytical powers, an insatiable appetite for delving, and an indestructible scientific curiosity. He also ought to possess powers of orderly and clear exposition that would ornament

the ablest teachers in undergraduate subjects. Such men are not found in large numbers. Would that they were; for their influence may be wisely sought in undergraduate engineering instruction as well as in graduate work.

Moreover it is not only accomplishments of the present generation with which these teachers must be familiar. I do not concur with the thesis of some of my colleagues that modern scientists and notably the engineers can find little of interest or value in studying the past. On the contrary, I believe that no wide-awake, intellectually sound engineer can fail to secure both interest and value from familiarity with the characteristics of ancient peoples and the affairs of ancient nations. Among many other things one should learn from them a pragmatic optimism relative to our own period by observing the great accomplishment that can be produced by human strength even without the wonderful auxiliaries of today, provided the strength is applied under wisely planned management, and thus one should recognize the probably even greater advantage of wisdom in management today, when we may make effective use of modern unintelligent but powerful auxiliaries to human labor.

It is also wise for the engineer who hopes to become a man of creative importance in the industries to study the influence which is impressed on society by applied science and improved economic theory. In the ancient days only few enjoyed any fruits of the great things and the submerged 90 per cent were no better supported than domestic beasts. With us the contrast between the most favored and the least favored among the free residents of this nation is probably no greater than between the extremes in the minority patrician classes of Greece or Rome at their zeniths. Engineering teachers, and notably teachers of graduate students, should have evolved and enriched their social views by historical and philosophical reading.

To follow such threads even slightly, requires free reading, and a comprehensive library as source. For the depth and thoroughness needed for the special study of the gradu-

ate student, the library should be embracing and great in natural science and engineering. To secure the collateral influences, it should be reasonably comprehensive in the humanities.

I have earlier herein referred to the fruitfulness of such graduate study for graduates of particular promise. The statistics gathered through the office of the Society's Director of Investigation show that there is a demand for resident instruction to graduates. As far as data are available, the number of students registered as pursuing graduate work in engineering compared with the number of senior students in the academic year *1924–5* were:

Principal Branch.	Graduate Students.	Senior Students.
Mining and Metallurgical Engineering ..	67	332
Civil Engineering	84	2,271
Mechanical Engineering	89	1,831
Electrical Engineering	230	2,279
Chemical Engineering	153	746
Other branches	379	1,130
Total	1002	8,589

The data are not exact, but they are indicative of the relations. The total number registered as pursuing graduate work is not notable in comparison with the number registered as seniors, but it is large enough to merit attention, and it is growing. Graduate study in the engineering schools perhaps never should command a clientele larger than from 15 to 25 per cent as numerous as the seniors. It should however be provided for fittingly. Of all the 164 engineering schools which grant degrees in the United States and Canada but few have the combination of library, laboratory facilities and distinguished staff which enables them to carry on effectually in graduate work. In this exigency a definite policy, embarked upon by those engineering schools whose resources are absorbed by undergraduate instruction, of counseling any notably promising man in each senior class of the advantages of graduate study at an engineering school eminently manned

and equipped in the specific branch of his great interest, would bestow advantages on the students and credit on the schools. A somewhat sporadic student migration for graduate study is observable among the more richly manned and competently equipped engineering schools; and a tendency exists for graduates of the less richly manned to turn for graduate study to the more richly manned.

This is a favorable stage for this Society to establish a directive influence on post graduate study in the engineering schools. It would be a service to the 164 engineering schools, to the engineering profession, and to engineering education if this Society should express in resolutions the principle that graduate work in the engineering schools should be carried on only in those schools which are comprehensively equipped with libraries and laboratories and sufficiently manned so that the staff may enjoy freedom from excessive assignments of class-room hours; also that the teachers' assignment in undergraduate work should be made with full consideration that each teacher should have time for and be expected to carry on individual study and investigation well in advance of the conventional limits of knowledge set by the undergraduate curriculum. Such action by resolution would be a credit to the Society and educative to Boards of Trustees. It would result in better understanding between engineering faculties and Boards of Trustees. Graduate work in the engineering schools would for a period be substantially concentrated in a relatively few schools which are notably manned. Some graduate work would appear here and there in other schools around some exceptional individuals in the staff. Thus the whole would be fertilized but the major expense during the period of gradual fuller development of graduate work would be cast upon those engineering schools most capable of meeting it.

BY G. M. BUTLER,

Dean, College of Mines and Engineering, University of Arizona.

About a decade ago a conference of engineering and business administration educators was held in Washington, D. C., and the majority of the men in attendance concluded that more economics, accounting, etc., should be required in engineering courses. Such courses have been generally modified to a greater or lesser extent in accordance with the resolutions adopted at that time although few engineering colleges even now require as many units of such subjects as the conference specified as a desirable minimum.

The writer attended the meeting mentioned and aligned himself with the minority there. He stated that he believed that questions of cost and profit should be emphasized as much as possible while teaching technical subjects, and that engineering students should be frequently and strongly impressed with the fact that nothing is good engineering that is not also good business—that it is not profitable. He expressed the conviction however, that it would be a serious mistake to introduce twelve to sixteen units of business subjects into engineering courses, and he based his attitude on the following considerations:

I. Most engineering courses were already overcrowded, and new subjects could not be introduced without eliminating certain desirable required work. Moreover, determined efforts had been made for several years to emphasize fundamentals when formulating engineering curricula, and most courses were already fairly free from over-specialization. The difficulty was especially evident when considering courses in mining engineering, which are more varied than other engineering curricula. In addition to the English, mathematics, physics, mechanical drawing, plain surveying, strength of materials, and year of chemistry that are commonly regarded as essential fundamental studies for engineers, the mining student must complete two additional years of chemistry, a year and a half to two years of mineralogy and petrology, and a semester

of mine surveying besides the specialized mining engineering, metallurgical, and geological subjects peculiar to his course. Furthermore, because of the varied nature of the work he may be called upon to do, he must have some familiarity with all other branches of engineering. Business subjects could, then, be introduced only at the expense of very important fundamental subjects, of technical courses already reduced to what seemed irreducible minima, or of the few free electives regarded as so important and valuable.

While the argument that it would be extremely difficult to require a considerable proportion of business courses deserves consideration, it is admittedly a weak one. Capable and sincere men always manage in some way to do the things that should be done. No one deserves to consider himself an engineer who does not welcome difficult tasks which challenge his ingenuity. Five- or six-year courses are quite within the range of possibility, and many engineering educators regard them as desirable. They could easily include almost any reasonable amount of business subjects. The real question at issue is, then, is it desirable to require all engineering students to study twelve or more units of formal business subjects.

II. It seems decidedly unwise to force undergraduate students to pursue more than one or two subjects dealing with economics, etc., for the reason that the great majority of these young men find these subjects decidedly distasteful. This fact, alone, is not very significant. It is unfortunately true, however, that it is not the aim of most of these courses to make the students better engineers, but to prepare them for careers as business men and executives. In order to gain and retain the students' interest, they are repeatedly informed that administrative positions yield the highest salaries and are in all other ways most desirable, and they are encouraged to think that they are preparing themselves for such positions by taking commercial courses as undergraduates. In other words, while pursuing arduous and intensive courses to prepare themselves to become first-class technical engineers, they are permitted to gain the idea that such careers are far

from satisfactory and the opportunities offered therein are woefully inferior to those that obtain in a somewhat related pursuit for which they might as well prepare themselves. Would such an ambigious and absurd situation be tolerated in the training required for any other profession? Of course, not!

III. It appears to be self-evident that the attention of undergraduate engineering students should be firmly focused on the single aim of becoming skilled professional engineers, not administrators. If such a career is not sufficiently worthy and congenial to satisfy entirely any well qualified man, we engineering educators ought to close our schools. If we do not adopt the practice of fixing our students' attention entirely on engineering as a life work, we shall most certainly irreparably injure most of the young men, since it is undeniably true that a very small proportion of them will ever even have an opportunity to attempt to act as executives, and that an even smaller number possess the personality and peculiar qualifications without which no one can become a successful administrator. Real technical and administrative ability are rarely combined in one man, since the successful technician must be mainly interested in *things*, while the executive deals principally with men. The very aptitudes and inclinations that insure success in engineering tend to unfit a man for administrative work. Of course, notable exceptions to this statement exist, but it is a very significant fact that they *are exceptions*. Furthermore, it should be remembered that the small proportion of capable engineers who have achieved success as executives gained their positions without undergraduate training in business subjects.

If we admit that few of our students will ever occupy executive positions, or fill them satisfactorily should some whim of fortune place them therein, it is manifestly unjust to require all engineering students to take a considerable number of business courses for which they will have little or no use and to omit work which will certainly be valuable to them. We thereby penalize the great majority in order that a small

minority may, perhaps, profit—perhaps, because it is by no means certain that even this minority will appreciably benefit from the undergraduate business courses ordinarily required of engineers.

The situation would not be so serious if it were not filled with such potentialities for harm for the majority. Experience has shown that men who have taken graduate "Administration Engineering" courses practically never engage in engineering work thereafter, and it is hardly surprising to find that they very rarely succeed in obtaining administrative positions. Undergraduates who thus become improperly oriented toward their work because undue emphasis is placed upon business subjects are very apt to be decidedly dissatisfied with the technical work toward which their preparation has been primarily directed. To varying extents we ruin them as engineers, and are utterly unable to train them for successful careers as administrators.

By all means, insist that an engineer must be a good business man, interweave into the engineering training, preferably in the technical courses themselves, such business training as is desirable, and strongly encourage the students to think in terms of profit and loss, but carefully avoid even mentioning to undergraduate or inexperienced graduate engineering students the possibility that they will find it advantageous to abandon engineering and engage in administration.

What has all this to do with the new course at the University of Arizona? A great deal, since this course has been specially planned so as to avoid all of the dangers mentioned.

After returning from the Washington Conference, the writer seized every opportunity to discuss his views with the leading mining administrators of the Southwest, and he found them in almost complete agreement with him. He learned that one of the largest mining companies in Arizona each year made it a practice to employ a number of exceptionally promising, recently graduated engineers. They were enrolled in a carefully planned training course which offered unusual opportunities for them to demonstrate the possession

of executive ability. It was hoped that men to fill subordinate administrative positions could be recruited from their ranks, but the results had been very disappointing. Although most of them were good technical men, they completely lacked administrative ability.

Upon inquiry it was found that there existed a strong demand for men to fill minor administrative positions, and that the mining executives generally were convinced that men who had enjoyed engineering training and experience made the best industrial executives in the very rare instances that they were also temperamentally qualified for such work.

Recognizing the extremely friendly attitude of the great Arizona mining companies and their willingness to cooperate in the work, and determined to avoid the conditions that the writer has criticized, the University of Arizona decided to try to fill this need by conducting a cooperative graduate course in the administration of mineral industries.

A distinctive feature of this course is the care with which the students are selected. No one is admitted until after he has had several years of practical experience subsequent to graduation from a good mining college. The average period of experience of the six men who were finally permitted to matriculate last year was about twelve years.

Believing, however, that something else besides experience was required before a man should be allowed formally to prepare himself for administrative work, it was decided that no one should take the course unless specially selected or very highly endorsed by his employers. In writing to the references given by applicants, the employers were fully acquainted with the nature and purpose of the course, and were cautioned to recommend no one unless he had demonstrated the possession of such qualities as successful administrators must possess. It was recognized that such men would probably eventually work their way into executive positions without formal training; and all that the University hoped to do was to shorten and make easier this period of advancement, and

to give the students a rather unusual opportunity to prepare themselves to administer large enterprises.

The work on the campus included courses in Public Speaking, Business and Mining Law, Economics (including Advanced Accounting), Money and Banking, a daily seminar in Administration, etc. This campus work alternated with extensive field trips during which the operation of the largest mining and smelting plants in the state was observed and intensively studied. The following companies cooperated with the University by allowing their plants to be used as laboratories in which the application of the theoretical principles taught on the campus was demonstrated: The Miami Copper Company, the Old Dominion Company, the Inspiration Consolidated Copper Company, the International Smelting Company, the Magma Copper Company, the Ray plant of the Nevada Consolidated Copper Company, the Hayden plant of the American Smelting and Refining Company, the New Cornelia Copper Company, the Bisbee mines and the Douglas Smelter of the Phelps Dodge Corporation, the Bisbee mines and the Douglas Smelter of the Calumet and Arizona Mining Company, the Shattuck-Denn Mining Corporation, the Jerome mines and the Clarkdale Smelter of the United Verde Copper Company, the Jerome mines and the Clemenceau Smelter of the United Verde Extension Mining Company, the Greene-Cananea Copper Company, the Apache Powder Company and several smaller mining companies.

Many different mining methods and the latest practice in smelting, concentrating, and leaching copper ores have been observed. Of more importance is the fact that all of the companies mentioned have freely given to the students every opportunity to see original records and methods, have thrown open their cost books, have exhibited their methods of accounting, have made it possible for the members of the class to observe how problems encountered in conducting great enterprises are solved, and have done everything possible to make the visits profitable and pleasant for the students.

In order to avoid the possibility of disappointment, the

students are made to understand that, after completing the course, which leads to the professional degree of Administrative Engineer of Mines (A.E.M.) or Administrative Metallurgical Engineer (A.E. Met.), should they re-enter the employ of the companies for which they were working when they applied for admission to this course, they must expect no better positions and salaries than they last held and received, and their subsequent advancement must depend entirely upon demonstrated ability and worth.

Perhaps the most difficult problem connected with the course was to select and obtain a man in every way qualified to direct the work. The appointment of Dr. E. P. Mathewson, formerly President of the American Institute of Mining and Metallurgical Engineers, has proven to be a singularly happy solution of this problem. Dr. Mathewson is not only internationally recognized as an authority in the field of metallurgy, but he has filled many and varied executive positions of great responsibility, and, best of all, he seems to possess to an unusual degree the ability to select and train executives, since many men who now hold very important administrative positions began work under him. Certainly he has the complete confidence of the members of his class and of the officials of the cooperating companies, and nothing but praise has been heard of his work.

So carefully was the work planned before it was offered that only one major change is to be made next year. Instead of alternating the campus and field activities throughout the academic year, the entire first semester will be spent on the campus. In the second semester, two-week periods of campus and field study will alternate, and specially planned, intensive courses in commercial law and commercial English will, with the seminar discussions, fill the time spent on the campus during the second semester.

Although the value of the course cannot be conclusively demonstrated until after it has been given many years, and the men who hold the degree of Administrative Engineer of Mines have had an opportunity to demonstrate the practica-

bility of the training received, the cooperating officials are generally enthusiastic about the manner in which the work was conducted and the personnel of the class, and the students themselves are greatly pleased with the training obtained, as the following quotations from letters written by them prove:

"The field trips to the many mining camps and the round-table discussions of the various mining and metallurgical methods practiced by the several mining companies in the state have been of very great value."

"The hearty cooperation of the mining companies as evidenced by their opening up of their records and giving us permission to see their operative costs, and by their facilitating in every way possible our obtaining detailed information and data of their technical and business methods has given me a broader and clearer conception of the various problems with which they are confronted."

"Taking it by and large, I earnestly believe that the course offers an excellent means of intensive training that can only be duplicated by many years of practical experience in an executive capacity."

"The knowledge obtained on the field trips is something that cannot be learned anywhere else, or under any other conditions because the mining companies would not take the trouble to throw their books open to any individual as they do for your class. The knowledge obtained from the books and operating details they so willingly give the class can never be obtained under any other circumstances."

"I feel that the course has given me a new viewpoint which can best be defined as a viewpoint from the business angle. I do not believe that it would be possible to obtain this viewpoint in any other way except through many years of experience in the field of practical operations.

Such is the experiment in engineering education that the University of Arizona is making. That the idea can easily be adapted by other favorably situated institutions so as to apply to men engaged in other branches of engineering is evident. No claim is made that the problem of preparing industrial administrators has been completely solved, but the results already secured have been very encouraging, and the permanency of the course at the University of Arizona is apparently assured.

BY C. S. COLER,

The Westinghouse Electric and Manufacturing Company.

It has been said that one of the most interesting developments in biology is the chicken. It can be eaten before it is born or after it dies. I have been glad to see that this organization is taking an interest in the student before he comes to the college and after he leaves the college. It is significant of the modern trend of thought that education is a life process, that it starts early and should continue late.

Another significant thing that has been brought out by the deliberations of this organization, is the fact that the student interest ought to be the criterion of judgment as to the excellency of any program. In our desire to create a curriculum and systems and standards, we do not want to forget the student and his interest.

After listening to the discussions it seems to me that our whole problem can be stated in terms of a saturation curve starting, we will say, at the lower left going up in a straight line and then gradually bending off. When we consider a piece of iron as a part of an electrical machine, we run into that same curve. The research problems that we have in making that iron more effective in that machine are concerned with making that curve extend for a longer period in a straight line before it starts to saturate—before the law of diminishing returns begins to take effect.

As I see the problems we are discussing here, they are all concerned with trying to make the curve of education continue further in a straight line before saturation sets in. We begin to get a diminishing return in the individual himself when he loses interest or when he becomes concerned with too many outside activities, or when for one reason or another, such as ill health, he cannot go forward. We see saturation starting in an educational institution which has too many students, where the selection has not been carried on in the right manner, or where the faculty do not possess the capacity to stimulate and arouse interest in the student body. We often

see that curve starting to deflect appreciably after the young men get out of college and into industry. It is because of the lack of external motivation which the new environment offers or because of the amount of energy that is required of the men by their work.

Again the nature of our discussion is determined by our present location on this curve. When we are on the straight line of the curve, we are optimistic. We talk about problems of development and growth and expansion. When we get beyond the bend of the curve, we get a little pessimistic and talk about how we can correct certain tendencies that look to us altogether bad. From the discussion during this conference, I would say that we were somewhere near the knee of the curve.

In the graduate field, one of the remedies that is suggested to cure this tendency to saturate is the creation of a hybrid or a cooperative arrangement between industry and the schools. One of the things about Lindbergh that has attracted our attention is his use of the word "we." He uses it to typify the relationship between the human element and the machine element in our modern life and has caught a popular response. Our prosperity in America today is built on this use of the word "we." The corporation is the "we" idea applied to capital and labor. Insurance is the "we" idea applied to the risks of life and property. Our railroads, our plants and our great industries are the "we" idea in action, the working together of different parts that are essential to a composite whole.

The University of Pittsburgh since 1910 has had in operation in its engineering school the cooperative method of instruction. They have used the resources of the Pittsburgh district to advantage in training the young men who have came to their door desiring engineering instruction. These students have gone back and forth between the industries and the school and have woven for themselves an education which has been practical and sound. It was a logical outgrowth to extend this same principle to graduate work.

Our late chief engineer, Mr. B. G. Lamme, as one of his main interests, developed an engineering and design school in connection with our graduate student program at the Westinghouse Company. Dr. Sieg, Dr. Bishop and Dr. Bowman looked over this program and decided that in the interest of the student a cooperative arrangement would give the student the benefit of certain study which was fully up to graduate standard. That is the basis of the cooperative arrangement which has been entered into between the Westinghouse Company and the University of Pittsburgh.

Twenty-four hours are required for the Master's Degree by the University. After a careful investigation of the work which the selected graduates are doing with the Westinghouse Company, it was decided to give fifteen hours' credit for the work that is done on company time and on company pay. The other nine hours are to be taken by the students at the University of Pittsburgh in the evening so that they will not have to disrupt their practical productive period in industry. Twenty-eight men are enrolled on this program at the present time and we believe that some sixty men will register during the present year.

I would like to quote a portion of an editorial which appeared recently in the Journal of the American Society of Mechanical Engineers, by Mr. George A. Stetson, Associate Editor of the Society, commenting on this cooperative arrangement:

"This significant extension of the so-called cooperative idea in engineering education to candidates for the higher academic degrees serves a two-fold purpose in so far as the student is concerned. Not only is he doing advanced academic work under ideal surroundings of theoretical and practical balance, thereby spending the transition period between school and industry, in an organized adaptation to a new environment, but he does this with a gratifying sense of economic independence and justification lacking in graduate courses in study because he is gainfully employed during his course of study and because his employers know and approve of this

expenditure of his energy. Whatever hard-hearted motive of building for the future may have prompted the Westinghouse Company to enter upon this educational policy, the benefit to the young engineers in their employ is none the less real and the significance of the step is a development of engineering education none the less important. The success of the scheme from all points of view will be watched with interest by educators and industrialists and should lead to imitation in localities where notable schools and industries exist."

The pamphlets which have been distributed contain the detailed announcement of the cooperative program. It is too soon as yet for either party to this cooperative arrangement to know just what the ultimate results are going to be, but judging from the standpoint of the interest of the student, it seems to me that there is no doubt as to the ultimate outcome.

In summarizing, I might say that the arrangement meets the popular demand for higher education. It meets the economic need of the student. It gives the university full-sized graduate classes and provides men for the industry and for the engineering profession who are qualified to shoulder the more advanced responsibilities which are required by this age. When we recognize that the high school enrollment in this country for a number of year has increased nine times faster than the population and that thousands of men are now going to college, and when we realize that the educational status of any individual after all is a relative matter, we can see that it is going to be necessary for certain men to pursue their studies far beyond the undergraduate curriculum, if they are going to occupy the position in the coming years that the college men occupied in the past generation. I personally think that this cooperation between industry and educational institutions is one way to work out an economic solution of the problem which will enable us to continue further the straight part of the saturation curve which represents the effect of the law of diminishing returns in this field of education.

DISCUSSION.

W. H. TIMBIE: I want to congratulate the University of Pittsburgh and the Westinghouse Electric and Manufacturing Company on taking this important step in cooperative education. These institutions years ago entered into cooperative arrangements whereby students at the University of Pittsburgh were given practical experience in the plants of the Westinghouse Company. For these two institutions to extend this work so that the University gives engineering instruction to employes of the Westinghouse Company seems but a natural step. I am rather surprised that so much time elapsed before this step was taken. The cooperative arrangement between the Massachusetts Institute of Technology and the General Electric Company was put in operation several years after the Pittsburgh-Westinghouse arrangement. But for two years the Institute has been conducting an engineering course for General Electric employes located at Lynn, and this year we graduated our first class in this course.

The M. I. T. plan is a little different from the Pittsburgh plan. All the regular instruction is given by members of the M. I. T. faculty. Instead of the enrolled men coming from the works to the Institute, the Institute sends members of its instructing staff down to Lynn. The course consists of three semesters study and class work at the plant and one semester work in residence at the Institute. In order to be enrolled in this course, the applicant must be an engineering graduate who has completed the equivalent of our undergraduate work in electrical or mechanical engineering. He makes application in the usual way and his credentials are passed upon just as those of any other applicant for the Master's degree at the Institute. Successful candidates are formed into classes and are met twice a week in the classrooms of the General Electric Company at Lynn by members of the instructing staff at the Institute. The length of the class period is one and a half hours. Six hours a week study is supposed to be put on the classroom work. This schedule is carried out from October to June, with a Christmas recess, and is resumed

again in the following October and continued until February, at which time the successful candidates become resident students at the Institute for one semester.

I think the University of Pittsburgh-Westinghouse plan is sure to be very successful because of the instant success which our plan has attained. Some of the highest standing men to whom we granted Master's degrees at the last Commencement were members of this group.

A. M. GREENE: Did you say three semesters?

PROFESSOR TIMBIE: It takes three semesters of study at the plant and one semester at the Institute, making two full years. The classroom work at the plant is all on the Company's time. In addition to this, the Company continues the salary of those men who are taking their final term at the Institute. This salary, however, is in the nature of a loan which the men are expected to pay back out of their future earnings. At present there are sixty-five men enrolled. The first class started with twelve electrical engineers and eight mechanical engineers. We graduated seven electrical engineers and five mechanical engineers. We are gratified that the mortality in this kind of a course is so low. We had really expected a much greater mortality.

D. C. JACKSON, JR.: Is there any specific instruction by the General Electric Company's staff of men taking this course? Who selects the men and how are they selected?

PROFESSOR TIMBIE: The only instruction given by men of the General Electric staff is that given by some of the engineers in connection with the theses. In order to obtain the Master's degree, each student must complete a Master's Thesis in addition to doing the regular classroom work. These theses can be done either at the plant or at the Institute. In every case, however, the thesis is under the immediate supervision of a member of the instructing staff at the Institute. Engineers of the Company often assist the Institute in looking after some details of the thesis work. In this sense they may be said to be instructors in this course.

The final selection of the students in this course is done

entirely by the Institute. In order to apply, a man must have the recommendation of the Educational Committee of the Lynn plant of the General Electric Company. His application and credentials are passed upon at the Institute just as the application and credentials of any other candidate. In the present class are graduates of Brown, West Virginia, Queens, University of California, M. I. T., Harvard, Carnegie Institute of Technology, Texas University, Georgia Institute of Technology, University of Virginia, University of New Hampshire and University of Maine.

In brief, this work is a post-graduate course, conducted by the Massachusetts Institute of Technology at the Lynn works of the General Electric Company. Instead of bringing the students to the Institute, we have, in this instance, merely brought the Institute to the students for part of their work.

DEAN GREENE: Might I ask Mr. Coler what the twenty-four hours would mean at Pittsburgh? Does that mean two years' full work?

MR. COLER: The fifteen hours' credit which is given for work done at the Westinghouse Company is divided into two parts: Five hours for what we call our engineering school which consists of three months' full time instruction, under engineers who have been appointed as faculty members of the University of Pittsburgh, and whose standing has been recognized. The ten-hour credit goes to a still smaller selected group of men who qualify for the advanced design school consisting of six months of full time instruction on Company time. This work is not work in the shop; it is study directly under the direction of qualified engineers. The students are paid for this time. You will see then that some men receive three months' full time instruction while a still more select group receives six months' additional. Nine months' full time instruction for the more advanced men. For this nine months' full time instruction, fifteen hours' credit is given toward the twenty-four hours' credit required for the Master's Degree. This also may apply to the Doctor's Degree. It is possible to secure the Master's Degree in eighteen months.

Some of the boys will probably take two years and once in a while we may have somebody who can do it in one year. We would not recommend the latter.

W. E. WICKENDEN: How highly selected are the men who are eligible for the course and what previous experience with the Company and length of service are they expected to have before they become eligible for admission?

MR. COLER: The first choice is made when we select men from the various colleges. This year we had eighteen hundred applications for the graduate student work. From that group we selected three hundred men, one out of six. Of these three hundred men, we will finally select one hundred who will receive the benefit of the engineering school which carries with it the five hours of credit. Out of that one hundred we will select perhaps thirty or forty who will receive the benefit of the further instruction for six months which carries with it a credit of ten hours. It means in most cases that the instruction at the Company will carry over into the second year after the men have graduated, although at times the nine months of instruction is all accomplished in the first year. In addition to that, the men work in the shop for which they receive no specific credit on this program. Does that answer your question?

MR. WICKENDEN: Yes, thank you.

DEAN GREENE: Might I ask if the regular shop work time is curtailed at all so that these men may do the work in the school or is that at night?

MR. COLER: The shop work is altogether eliminated during the period the men are attending the schools. Between the engineering school and the design school, there would be considerable shop work and preceding the engineering school there is shop work. We do not try to select the men for this advanced work without considerable previous contact with them.

PROFESSOR BOYD: May I ask how they get the other nine hours?

MR. COLER: As regular students in the evening school at

the University of Pittsburgh, for which they pay the regular fee. That fee is not paid by the Company and the time they spend in graduate work is not paid for by the Company.

PROFESSOR GARNER: To what extent is the engineering work of an exploratory or research nature as against the usual process?

MR. COLER: I believe I will call on Dean Sieg to answer that.

L. P. SIEG: Mr. Coler did not mention, of course, the nucleus of the graduate work which after all is the research; and this in addition to the twenty-four course credits that are required. The twenty-four credits represent simply the academic study.

We treat each case individually. For the Master's Degree a student may, if he wants, work exclusively in one field. He had better, however, carry a major and a minor. Take a typical student who is in the electrical design division (there are two, electrical and mechanical), and who has earned fifteen credits in the field of electrical engineering. It is better for him to earn the additional nine credits in fundamental fields such as mathematics and physics, with now and then a peculiar case in which the credits are to be earned in the field of economics. These courses in mathematics and physics are the standard courses offered anywhere to graduate students and represent advanced graduate work in these two fields. They are taken slowly. A student may not take more than about four semester hours at one time after he has finished his fifteen because you see he is then a full-time employee of the Company with his responsibility for the full day's work. Naturally, he can not expect to have the time to study so as to go on so rapidly as he did in earning his first fifteen credits.

The research may be done on the student's own time, after he has earned his course credits, at the laboratories of the University, working evenings and Saturday afternoons. We recommend in many cases that the student get leave of absence from the Company to spend six months in intensive research, or, if the problem is approved by the officials of the Company and by the authorities of the University, the re-

search may be done in the Company's own plant after the credits have been earned. You will all recognize this is a delicate situation where the research done in the Company's plant should naturally be kept highly secret. We distinguish between purely technical research that may not logically be counted towards a degree and research in fundamentals. We have made arrangements whereby the usual publicity that necessarily goes with a thesis can be halted for a time, say two years if necessary; but ultimately the thesis is published.

PROFESSOR CLARK: I would like to ask Mr. Coler how many men, if any yet, have finished the requirements granted to Master's Degrees. I would also like to find out how many remain in the employ of the Company and if there is any extent or any manner of obligating men to return to the Company, remaining with the Company after their work is done.

MR. COLER: We have had one man so far qualify for the Ph.D. degree, preceding the time that this arrangement was entered into. Since the arrangement was only officially entered into on the first of January of this year, we have had no men receive the Master's Degree under this arrangement.

PROFESSOR CLARK: I am wondering how much they feel obligated to return to the Company.

MR. COLER: There is absolutely no obligation there any more than is implied by the agreement. There are no papers to be signed, no obligations entered into other than the regular employment obligations. In the past our record has shown that about fifty-one per cent of the technical men who come with us stay over a period of ten years or longer. Of the total number of men that we select each year, a percentage is selected for the purpose of being trained for operating company work and of course in addition we have some turnover during the period, but we believe that throughout our program there ought to be no fixed contract obligating a man to stay. We say to the man he must make good with us every day, and on the other hand, we obligate ourselves to make good with him every day. It is something like keeping the juice on the

wires. You either have light or you have not. If we had a contract with a man, to keep him in our employ when he did not want to stay, we do not believe it would be mutually satisfactory.

DEAN GREENE: Will you keep him if you do not want him?

MR. COLER: If we find we are in wrong, we want to get off as quickly as possible. I think when we all get around to that basis, we will be better off. When the colleges find a man who does not fit, they ought to put him out. I feel that a man in school ought not to continue for four years and then try something else. This principle should be carried on all the way through—perfect freedom of choice in so far as it can be made.

PROFESSOR CLARK: Do you expect a larger percentage will remain with the company, ninety per cent or so?

MR. COLER: We hope a hundred and ten per cent will stay with us. You folks hope that. If you start out with a hundred freshmen and graduate thirty, you regret that you do not graduate more. It is a part of that saturation effect I have been trying to outline without a blackboard—the loss of men whom we hope would go through, but if they are not qualified or not interested, then that loss is a good thing. It gets them out of the way so that we do not waste time on them.

R. I. REES: After the three months' period, is there an elimination process before they enter the succeeding six months' period, making the total of nine months? What happens to those three months' men?

MR. COLER: Of the men who go through the three months' program, forty out of the hundred will be selected to go through the additional program. They will be selected on the basis of their mentality, their fitness for that particular kind of work, and the record they have made.

In our grading program for trades' apprentices we use a forced distribution. An "A" man must be in the top quarter; a "B" man in the middle half; a "C" man in the bottom quarter. We find this method of grading better than the old method we had of letting the instructor give as many "A's"

as seemed right. Some of the instructors seemed to use this power like some of the politicians used their prerogatives.

CHAIRMAN KETCHUM: Industry is following some of our problems in psychology. They are trying to grade from a curve and I think most of us are doing our best to eliminate that relic of barbarism. One thing I do not stand for is grading from curves.

MR. COLER: If you have a hundred men and they all get "A's," you haven't the proper grading system. If you use a finer scale, you will always find some are better than others.

DEAN GREENE: In carrying out Mr. Rees' direction, the sixty men are not lost, they are kept within your student course and proceed with it.

MR. COLER: They go ahead on regular jobs and then say, "Now can I get in?"

We say, "Let's see what you have done to warrant it."

Whenever there is a matter of economy concerned, there is an element of barbarism. Sometimes I think maybe a little more economics in the college administration would not hurt. When we have to buckle down to an economic administration, we are probably all better off. However, we would not want a college to spend only as much money as it earns.

CHAIRMAN KETHUM: Industry begins on money that the college has spent and then proceeds to capitalize.

MR. COLER: The colleges are the flower of civilization and we can not grow flowers unless the roots of industry are there to support them.

E. R. HEDRICK: I would like to say a word which may be unpopular regarding the other side of this question, regarding something scholastic, more in line with our graduate schools of the past,—which I think you as engineers need. I am not at all out of sympathy with the types of graduate work that have been discussed already and I believe that they will doubtless best suit the majority. However, you engineers in this country need a type of scientific leadership which you are missing which Europe has and which we in America have not: the type of engineer highly trained in the fundamental

sciences, not as our engineering graduates are, but as our graduate students are in physics, in chemistry, and in my own chosen subject of mathematics.

I think that just this word is all that is needed. I happen to know through one or two things that have reached me, that there are men in this country now doing that type of work. This suggestion is therefore not academic. I should mention some such men as Steinmetz of revered memory, but they have not passed away. There is published in the *Bulletin of the American Mathematical Society* a paper by Carson of the Bell Industries in New York City, on a highly mathematical subject desirable from the standpoint of the Bell Industries. I know of a great deal of other work of that type being done. That type of work cannot be done in connection with the industries. For that you need to have a development of a different sort, a development truly graduate in character and of absolutely scientific character, as is the rest of the graduate work in our universities. I see no possibility of development of that sort of thing otherwise and I think that for the future progress of engineering work in this country, you will need, not many men, of course, but you will need some men. For the majority doubtless the work that has been described this morning is exactly what is needed. Those who are to be the leaders of our engineering schools in this country, however, need that type of training which will enable them to see clear through and beyond all existing engineering.

PROFESSOR WALTER: There is a phase of this question which is related to the smaller school, which I would like to hear discussed a little more. The consensus of opinion among the educators seems to be that the small school should not do any graduate work. I do not know whether I understand exactly how they mean to construe that or not. I do not think that the smaller schools should give up entirely the graduate work, and I would like to give a few reasons why I think they should do just a little. Of course we realize they are not in a position to give some of the courses the larger schools give, but I think there are some reasons why they should attempt a very limited graduate program.

First, the presence of the graduate course, as all of the men specially in the larger schools will understand, is necessary, or at least helps to raise the standard of the undergraduate courses. If there is no graduate work being carried on in smaller schools, I think you will find that the program in the undergraduate schools suffers and will be down on a much lower grade.

Another point is, if there is no graduate work or research work going on among the faculty of the smaller school, I think you will find the instructors will get stale, will not keep abreast of the improvement, and the advances in the profession. I think there should be some graduate work going on for that one reason. There is an administrative question which comes up if it is just being done as private work. A good many of the presidents of the universities will say that is something you ought to do on your own time, whereas if it is connected with the program of the school more or less, you will be given an allowance and the instructors will be given time to do the graduate work they want to do.

Then, the State-run universities and smaller schools are developing a certain amount of graduate work in physics, chemistry, and so forth, and the graduate work in the engineering is necessary to show that we are on our toes.

Another point I would like to make is that interest in this work needs to be kept up, and if the men who have charge of that take the right attitude and where they can, send the men to the better schools, I think that this will be worked out properly as it should be. There are some men who should study because they can not go to another place and take graduate work. The last point is, there are particular problems of the State which can be best covered by the local university.

CHAIRMAN KETCHUM: I am sorry we will have to bring the discussion to a close. I regret we have not brought out the fact that in numerous institutions the graduate work in engineering is on the basis that Professor Hedrick has wished. For example, at the University of Illinois, the graduate work in engineering is under the direction of the graduate school,

graduate instructors are approved by the graduate committee as are all other instructors in graduate work, and no department is permitted to give graduate work unless the courses and the men are approved by the Graduate Committee.

The University of Illinois confers the degree of Doctor of Science in Engineering on the same basis as Doctor of science in any other field, and last commencement we conferred two degrees of Doctor in engineering. Both of these men were very unusual men who had, I think, completely filled the ideals outlined by Doctor Hedrick. And there is no question but what we have a need for different kinds of graduate work. Personally I am quite sold on the type of graduate work that I have just outlined. This is a very well worthwhile subject, and I hope that we may continue it in the future discussions and in future meetings.

REPORT OF THE SECRETARY, 1926–27.

The Society, at this convention, is closing its 35th year of activity in engineering education. It is quite fitting that this Society—the oldest organization in the world devoted exclusively to the promotion of engineering education—should be the first to establish schools to teach teachers to teach.

Summer Schools.

The summer school for engineering teachers is an outgrowth of the general investigation of engineering education that has been in progress for the past three years under the direction of the Board of Investigation and Coordination.

The purpose of the schools conducted by the Society at Cornell and at Wisconsin this summer is the development of improved methods of instruction, particularly in the subject of mechanics. This subject was selected for the first summer school because it is fundamental in all engineering curricula, and because all engineering teachers have a working knowledge of the subject and can thus appreciate discussions of methods of teaching it. The session at Cornell begins Wednesday, July 6, and closes Tuesday, July 26. The session at Wisconsin begins on Monday, July 11, and closes on Friday, July 29.

The 1927 summer school for teachers was made possible by a gift of $7,500 from the Carnegie Corporation. The schools are under the direct supervision of W. E. Wickenden, Director of Investigations, and H. P. Hammond, Associate Director of Investigations.

Board of Investigation and Coordination.

The Board of Investigation and Coordination of the Society will present a report for your consideration at this meeting. This report deals with the results of the three-year

investigation made possible by the grant of $108,000 from the Carnegie Corporation. The Corporation has given to the Society an additional $10,000 to defray the cost of publishing the bulletins of the Board. The Corporation has expressed satisfaction with the results obtained in this investigation, as indicated by the gift of $7,500 for summer schools.

To make use of the facts gathered by the investigation, the Board has planned a two-year program of experiment, demonstration, training and supplementary investigation. Funds needed for the two years are estimated at $100,000. These are being provided by the four national engineering societies, the Engineering Foundation, individuals and industries. The Society is greatly indebted to Mr. Alfred A. Flynn, Director of the Engineering Foundation, for his energetic work in raising these funds and for acting as treasurer of the fund.

Division of Deans and Administrative Officers.

The Division of Deans and Administrative Officers held a joint meeting with the Board of Investigation and Coordination in Washington, D. C., November 19, 1926. Dean M. S. Ketchum, Chairman of the Division, presided. The meeting was preceded by a dinner at the Willard Hotel on November 18, at which Dr. Frank Aydelotte, President of Swarthmore College, outlined the seven topics which would be discussed at the joint conference the next day. These topics were:

1. Structure of Undergraduate Engineering Curricula.
2. Social and Economic Content.
3. Admissions.
4. Non-Graduating Students.
5. Exceptionally Gifted Students.
6. Teaching Personnel.
7. Scope of Engineering Education.

Sections and Branches.

Professor W. S. Rodman, Chairman of Sections and Branches, has been very active this year in promoting inter-

est in the different sections and branches. One new section was formed—the Greater New York-New Jersey Section.

Committees.

The committees of the Society have been working hard. Some of them will have reports at this meeting but many will not, due to the fact that their work is continuous. Reports are not expected of each committee every year. The Committee on Policy and the Committee on the Change of Name of the Society will report this year. These reports are of vital interest to every member of the Society.

Much credit is due to the members of the Committee on Institutional Membership. Each application for institutional membership is referred to this committee. The committee investigates the status of the institution, reports to the secretary, who in turn presents the recommendations to the Council of the Society.

Publications.

Each issue of the Journal of Engineering Education has contained some material bearing on the investigation being conducted by the Society. In order that the members might have the latest information, some of the numbers have been delayed. A year book has been issued and in this an occupational distribution of the membership has been added for the convenience of the members. The publication of a year book involves considerable time for preparation, checking, and rechecking.

All material issued by the Board in the Journal may be secured in pamphlet form at cost, at the Lancaster Press, Inc., Lancaster, Pa.

Employment.

The Secretary has received numerous requests from individuals for teaching positions, and many requests from institutions for teachers. We have endeavored to assist both and in several instances very good connections have been made.

LAMME AWARD.

The Committee on the Lamme Medal has had Erwin F. Frey, Sculptor, of Columbus, Ohio, working on the designs and considerable progress has been made. It is hoped to have the designs completed very shortly.

MEMBERSHIP.

There has been a substantial increase in membership this year. We now have 1,990 individual members and 120 institutional members, making a total of 2,010 members.

F. L. BISHOP,
Secretary.

REPORT OF THE AUDITORS.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

STATEMENT OF CASH ACCOUNT.

June 17, 1927.

Balance on Hand—June 12, 1926		$ 624.08
Receipts:		
Current Dues	$ 8,877.83	
Back Dues	902.00	
Dues in Advance	142.00	
Sales of Publications	3,117.18	
Advertising	1,278.50	
Interest, Exchange, etc.	81.44	14,398.95
Total		$15,023.03
Disbursements:		
Cost of Publications	$ 6,646.40	
Cost of Proceedings	440.18	
Honorarium for Secretary	1,000.00	
Clerical Assistance—Secretary's Office	2,200.00	
Postage, Expressage, Telephone, Telegraph, Sundry Printing and Office Supplies	608.74	
Expenses—Iowa City Meeting—1926	304.52	
Increase in Petty Cash Fund of Secretary's Office	100.00	
Total for 1926–27	$11,299.84	
Payment of balance of 1925–26 Expenses	221.23	
Prepaid expenses—University of Maine Meeting —1927	237.10	$11,758.17
Balance on Hand—June 17, 1927		$ 3,264.86

Society for the Promotion of Engineering Education.

Balance Sheet.

June 30, 1927.

Assets.

Cash:		
Current Fund	$ 3,264.86	
Petty Cash Fund	300.00	
Life Membership Fund	544.40	$ 4,109.26
Certificate of Deposit—		
Mellon National Bank of Pittsburgh, Lamme Medal Fund 3% Int. 1¼ yrs.		5,160.00
Prepaid Expense—University of Maine Meeting—1927		237.10
Inventory		941.00
Accounts Receivable:		
Current Dues	$ 500.00	
Publications	974.56	
Advertising	800.00	2,274.56
Furniture and Office Equipment		183.35
		$12,905.27

Liabilities.

Accounts Payable		$ 1,450.00
Life Membership Fund		544.40
Benjamin G. Lamme Fund		5,160.00
Prepaid Membership Dues		142.00
Surplus Account:		
Balance July 1, 1926	$ 1,838.48	
Add: Contributions	1,314.85	
Total:	$ 3,153.33	
Less: Payments for year 1925–26	221.23	
Net Balance July 1, 1926	$ 2,932.10	
Surplus for this year	2,676.77	5,608.87
		$12,905.27

Society for the Promotion of Engineering Education.

Income and Expense Account.

At June 17, 1927
for the year ending June 30, 1927.

Expense.

Cost of Bulletins	$ 7,896.40
Cost of Proceedings	440.18
Expenses—Iowa City Meeting	450.52
Honorarium for Secretary	1,000.00
Clerical Assistance—Secretary's Office	2,400.00
Postage, expressage, telephone, telegraph, Sundry Printing and Office Supplies	608.74
Total	$12,795.84
Surplus for Year	2,676.77
	$15,472.61

Income.

Current Dues	$ 9,402.93
Back Dues	402.00
Sales of Publications	4,091.74
Advertising	1,494.50
Interest, Exchange, etc.	81.44
	$15,472.61

NEW MEMBERS.

BECKER, L. M., Head of Department of Mathematics and Mechanical Engineering, Hibbing Junior College, Hibbing, Minn. A. P. Poorman, H. E. Mayrose.

BAVLY, DAVID M., Assistant Professor of Mechanical Engineering, N. D. Agricultural College, Fargo, N. D. A. P. Poorman, H. E. Mayrose.

BLISS, ZENAS R., Assistant Professor of Engineering, Brown University, Providence, R. I. W. J. Risley, F. L. West.

BOYKIN, HENLEY P., Assistant Professor of Civil Engineering, Va. Military Inst., Lexington, Va. A. P. Poorman, S. B. Folk.

BULLARD, JAMES A., Professor of Mathematics, United States Naval Academy, Annapolis, Md. J. E. Boyd, C. L. Walker.

CAMPBELL, ROBERT D., Assistant Professor of Mechanical Engineering, Southern Methodist Univ., Dallas, Texas. A. P. Poorman, E. R. Maurer.

CATHER, CARL H., Assistant Professor of Mechanics, West Virginia University, Morgantown, W. Va. A. P. Poorman, E. R. Maurer.

CONVERSE, FREDERICK J., Instructor in Civil Engineering, Calif. Institute of Technology, Pasadena, Calif. W. J. Risley, W. S. Franklin.

COX, WILLIAM J., Assistant Professor of Engineering Mechanics, Yale University, New Haven, Conn. P. G. Laurson, W. S. Franklin.

DAY, JESSE E., Assistant Professor of Chemistry, The Ohio State University, Columbus, Ohio. E. A. Hitchcock, J. R. Withrow.

FICK, ADOLPH, Instructor in Civil Engineering, Marquette University, Milwaukee, Wis. A. P. Poorman, S. B. Folk.

FIELD, LAWRENCE N., Associate Professor of Drawing and Design, Michigan State College, East Lansing, Mich. A. P. Poorman, S. B. Folk.

FLANDERS, ROGER L., Assistant Professor of Civil Engineering, Oklahoma A. & M. College, Stillwater, Okla. C. L. Walker, W. S. Franklin.

GROSS, CHARLES F., Associate Professor of Marine Engineering and Naval Architecture, University of California, Berkeley, Calif. J. H. Robert, A. P. Poorman.

HARTWICH, FREDERICK C., Professor of Calculus and Mechanics, University of Dayton, Dayton, Ohio. S. M. Woodward, A. P. Poorman.

HIROTA, SEIITI, Director, Kobe Technical College, Kobe, Japan. H. H. Henline, W. E. Wickenden.

HOWELL, ERIC V., Assistant Professor of Civil Engineering, Cornell University, Ithaca, N. Y. C. L. Walker, J. E. Boyd.

HUDSON, ROSS C., Assistant Professor of Mechanics and Drawing, Clarkson College of Technology, Potsdam, N. Y. W. J. Risley, J. E. Boyd.

JONES, JAMES B., Assistant Professor of Experimental Engineering, Va. Poly. Institute, Blacksburg, Va. C. L. Walker, N. C. Riggs.

KERSTEN, HAROLD J., Instructor in Mathematics and Drawing, University of Cincinnati, Cincinnati, Ohio. A. P. Poorman, S. B. Folk.

KOCH, RUTH L., Assistant to the Dean, Speed Scientific School, University of Louisville, Louisville, Ky. B. M. Brigman, W. B. Wendt.

MCKINNON, JOHN C., Assistant Professor of Mechanical Engineering, Alabama Pol. Inst., Auburn, Ala. A. P. Poorman, E. R. Maurer.

MCLAURIN, BANKS, Instructor in Civil Engineering, University of Texas, Austin, Texas. A. P. Poorman, C. A. Wiepking.

MOOTS, ELMER E., Chairman, Department of Mathematics and Engineering, Cornell College, Mt. Vernon, Iowa. A. P. Poorman, H. E. Mayrose.

NYGARD, ERIC, Instructor in Civil Engineering, Union College, Schnectady, N. Y. P. G. Laurson, W. S. Franklin.

PETTENGILL, TRUE E., Instructor in Mathematics, University of Detroit, Detroit, Mich. A. P. Poorman, H. E. Mayrose.

QUIGLEY, LEON V., Technical Editor, Bakelite Corporation, The Shelton Hotel, New York City. S. S. Edmands, A. L. Cook.

RICHMOND, ALLEN P., JR., Assistant Professor of Civil Engineering, Dartmouth College, Hanover, N. H. W. E. Riggs, J. E. Boyd.

SHAFFER, HAROLD A., Assistant Professor of Electrical Engineering and Drawing, Bucknell University, Lewisburg, Pa. W. J. Risley, W. F. Franklin.

SLACK, EDGAR B., Assistant Professor to Physics, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. P. G. Laurson, J. H. Dyble.

SPIETH, BENJAMIN, Associate Professor of Applied Mechanics, Kansas State Agri. College, Manhattan, Kans. S. M. Woodward, A. P. Poorman.

STEWART, FLOYD R., Professor of Mechanical Engineering, Cleveland College of Cooperating Engineering, Cleveland, Ohio. A. P. Poorman, S. M. Woodward.

STRANE, ALBERT P. Instructor in Electrical Engineering, Purdue University, Lafayette, Ind. A. P. Poorman, S. M. Woodward.

TAYLOR, EDWARD, Associate Professor of Mechanics, Pomona College, Claremont, Calif. A. P. Poorman, H. E. Mayrose.

TIMOSHENKO, STEPHAN, Research Engineer, Westinghouse E. & M. Company, East Pittsburgh, Pa. S. M. Woodward, E. R. Maurer.

TINGLEY, FREEMAN T., Instructor in Electrical Engineering, Bucknell University, Lewisburg, Pa. C. L. Walker, J. E. Boyd.

TUCKER, LEROY, Professor of Mechanics and Strength of Materials, Clemson Agricultural College, Clemson College, S. Car. A. P. Poorman, H. F. Moore.

TURRITTIN, HUGH L., Instructor in Mechanics, University of Wisconsin, Madison, Wis. A. P. Poorman, H. R. Maurer.

WADE, FRANK H., Assistant Professor of Physics and Mechanics, Lewis Institute, Chicago, Ill. A. P. Poorman, H. E. Mayrose.

WEGNER, WALTER W., Assistant Professor of Civil Engineering, Leland Stanford Junior University, Stanford University, Calif. A. P. Poorman, E. R. Maurer.

WENDT, KURT F., Instructor in Mechanics, University of Wisconsin, Madison, Wis. A. P. Poorman, H. E. Mayrose.

WHEELER, CHARLES A., Professor of Mathematics and Engineer, The Connecticut Agricultural College, Sterrs, Conn. C. L. Walker, J. E. Boyd.

WINDE, NORMAN H., Instructor in Engineering, Swarthmore College, Swarthmore, Pa. A. P. Poorman, H. E. Mayrose.

COMMITTEES FOR 1927–28.

1. *Executive Committee:* R. L. Sackett, *Chairman*, Pennsylvania State College, State College, Pa.; F. L. Bishop and W. O. Wiley.

2. *Publication Committee:* F. L. Bishop, *Chairman*, University of Pittsburgh, Pittsburgh, Pa.; O. M. Leland and R. L. Sackett.

3. *Program Committee:* R. L. Sackett, *Chairman*, Pennsylvania State College, State College, Pa.; C. E. Magnusson, T. E. French, F. L. Bishop and W. O. Wiley.

4. *Committee on Committees:* R. L. Sackett, *Chairman*, Pennsylvania State College, State College, Pa.; C. E. Magnusson, T. E. French, F. L. Bishop and W. O. Wiley.

5. *Institutional Division:* C. E. Magnusson, *Chairman*, University of Washington, Seattle, Wash.

6. *Sections and Branches:* W. S. Rodman, *Chairman*, University of Virginia, University, Va.; F. C. Bolton, H. S. Evans, D. C. Jackson, Jr., W. H. Kavanaugh and Hugh Miller.

7. *Policy:* G. B. Pegram, *Chairman*, Columbia University, New York City; F. L. Bishop, H. S. Boardman, John G. Bowman, A. A. Potter and C. F. Scott.

8. *Engineering Research:* M. S. Ketchum, *Chairman*, University of Illinois, Urbana, Ill. (1 year); V. Bush (4 years), D. A. Lyon (5 years), C. R. Richards (2 years), Albert E. White (3 years).

9. *Industrial Engineering:* P. F. Walker, *Chairman*, University of Kansas, Lawrence, Kans.; J. W. Hallock, S. T. Hart, S. Scrimshaw, G. H. Shepard, R. D. Thomson, and C. W. Beese.

10. *Mathematics:* E. R. Hedrick, *Chairman*, University of California at Los Angeles; J. A. Dent, T. M. Focke, D. C. Jackson, Jr., W. J. Risley and R. E. Root.

11. *Chemistry:* G. L. Wendt, *Chairman*, Pennsylvania State College, State College, Pa.; R. M. Bird, W. C. Ebaugh, Samuel C. Lind and H. C. Peffer.

12. *English:* J. Raleigh Nelson, *Chairman*, University of Michigan, Ann Arbor, Mich.; W. O. Birk, H. M. Ellis, Sada A. Harbarger, H. G. Pearson and H. C. Richardson.

13. *Physics:* W. S. Franklin, *Chairman*, Massachusetts Institute of Technology, Cambridge, Mass.; G. P. Bacon, A. W. Duff, Erich Hausmann, A. H. Patterson and O. M. Stewart.

14. *Metallurgy:* C. H. Fulton, *Chairman*, Missouri School of Mines, Rolla, Mo.; D. J. Demorest, Dorsey A. Lyon, R. S. McCaffery, Alfred Stansfield, Bradley Stoughton and F. A. Thomson.

15. *Civil Engineering:* A. H. Fuller, *Chairman*, Iowa State College, Ames, Iowa; F. H. Constant, F. O. Dufour, Horace Judd and J. R. Lapham.

16. *Mechanical Engineering:* A. C. Willard, *Chairman*, University of Illinois, Urbana, Ill.; A. M. Greene, E. A. Fessenden, J. A. Hunter, F. V. Larkin, G. L. Larson and R. S. King.

17. *Electrical Engineering:* Paul Cloke, *Chairman*, University of Maine, Orono, Me.; R. E. Doherty, F. A. Fish, H. H. Higbie, A. S. Langsdorf, T. R. Rosebrugh and H. S. Evans.

18. *Mining Engineering:* W. R. Appleby, *Chairman*, University of Minnesota, Minneapolis, Minn.; H. M. Boylston, E. A. Holbrook, T. J. Hoover, W. B. Plank, R. M. Raymond, F. W. Sperr.

19. *Drawing and Design:* T. E. French, *Chairman*, The Ohio State University, Columbus, Ohio; F. G. Allen, F. G. Higbee, H. M. McCully, O. A. Leutwiler, C. V. Mann and H. W. Miller.

20. *Standardization of Technical Nomenclature:* J. T. Faig, *Chairman*, Ohio Mechanics Institute, Cincinnati, Ohio; R. L. Daughtery, J. E. Emswiler and Sanford A. Moss.

21. *Chemical Engineering:* A. H. White, *Chairman*, University of Michigan, Ann Arbor.; C. A. Mann, H. C. Bashioum, R. H. Mckee and J. R. Withrow.

22. *Agricultural Engineering:* J. B. Davidson, *Chairman*, Iowa State College, Ames, Iowa; William Boss, S. H. McCrory, D. Scoates, O. W. Sjogren, H. B. Walker and R. B. West.

23. *Student Personnel Studies:* C. E. Seashore, *Chairman*, State University of Iowa, Iowa City, Iowa; W. J. Creamer, Jr., O. E. Eshbach, C. E. Hewitt, D. G. Paterson, J. E. Walters and Wayne E. Keith.

24. *Safety:* J. O. Keller, *Chairman*, Pennsylvania State College, State College, Pa.; M. E. Cooley, H. J. Hughes, Wm. T. Magruder and R. M. Raymond.

25. *Relations of Engineering Colleges with Railroads:* S. W. Dudley, *Chairman*, Yale University, New Haven, Conn.; M. S. Ketchum, Anson Marston, C. H. Mitchell, A. A. Potter, H. E. Riggs, G. F. Swain and F. E. Turneaure.

26. *Modern Foreign Languages:* M. E. Cooley, *Chairman*, University of Michigan, Ann Arbor, Mich.; J. B. Crenshaw, A. dePierport and J. R. Macarthur.

27. *Mechanics:* A. P. Poorman, *Chairman*, Purdue University, La-Fayette, Ind.; G. P. Boomsliter, J. E. Boyd, S. G. George, C. C. More, C. F. Paul and S. M. Woodward.

28. *Materials of Engineering:* H. C. Berry, *Chairman*, University of Pennsylvania, Philadelphia, Pa.; H. W. Hayward, H. F. Moore, G. C. Priester, H. H. Scofield and M. O. Withey.

29. *Orientation and Engineering Problem Courses:* F. C. Dana, *Chairman*, Iowa State College, Ames, Iowa; C. W. Beese, J. J. Richey, E. R. Wilcox and E. H. Wright.

30. *Lamme Award:* D. C. Jackson, *Chairman*, Massachusetts Institute of Technology, Cambridge, Mass.; F. L. Bishop, T. E. French and C. F. Scott.

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